Session 1.5

Interoperability Approaches & Lessons Learned

Paper 151

Interoperability Committee

Bob Parsons/ Mike Hogan

Interoperability Subcommittee

- Reports to System Architecture, Standards, & Telecommunications Committees
- 70 persons interested, 40 active
- "I" requirements @ User Service Level
- Studying 3 Cases to Establish a Procedure to Define "I" Requirements
- Preparing for December Workshop

Charter

To examine the cross cutting ITS systems and standards to assure that they 1) provide a range of products/services that permit various levels of user service performance and 2) assure different products work together, especially mobile and related infrastructure equipment. Define work tasks as needed.

General Strategy

- Identify Useful Material in National ITS Architecture

- Determine Stakeholders

- Develop Pertinent Questions

  Reports from : CVO Community Approach, NIST Experiences, Mayday Issues, Railway Concerns

- Discuss Degree of Interoperability and Assurance that is Desirable and Cost-Effective, e.g., Apogee Report Market Expectations

- Identify Resources Available to the Subcommittee

Initial Committee Strategy

1 **Identify/Evaluate Existing Definitions and Efforts and Analogous Processes and Forums** for "Lessons Learned" and an Appropriate Strategy for the ITS Industry

2. **Analytical-Approach**

- Prepare an end-to-end Diagram Depicting the Interfaces of all Transactions needed to provide an ITS Service (e.g., Starsman ETTM diagram)
- Form 3 Task Groups to Evaluate the Interoperability Requirement Analyses for 3 Different Priority Examples:
  - **Mayday** (Market Package 3/ Emergency Management) Chair: Andy Schoka (Mitretek)
  - **ETTM** (Starsman Cross-Application Example) Chair: Dick Schnacke (Amtech)
  - **Emergency Management** (EM2) **TMC-to-TMC** Chair: Jim Fukuda (Odetics)

ITS
America

Interoperability Definition

Interoperability: The ability of systems to provide services to and accept services from other systems and to use the services so exchanged to enable them to operate effectively together. (IS0 TC204 Doc. N271) *

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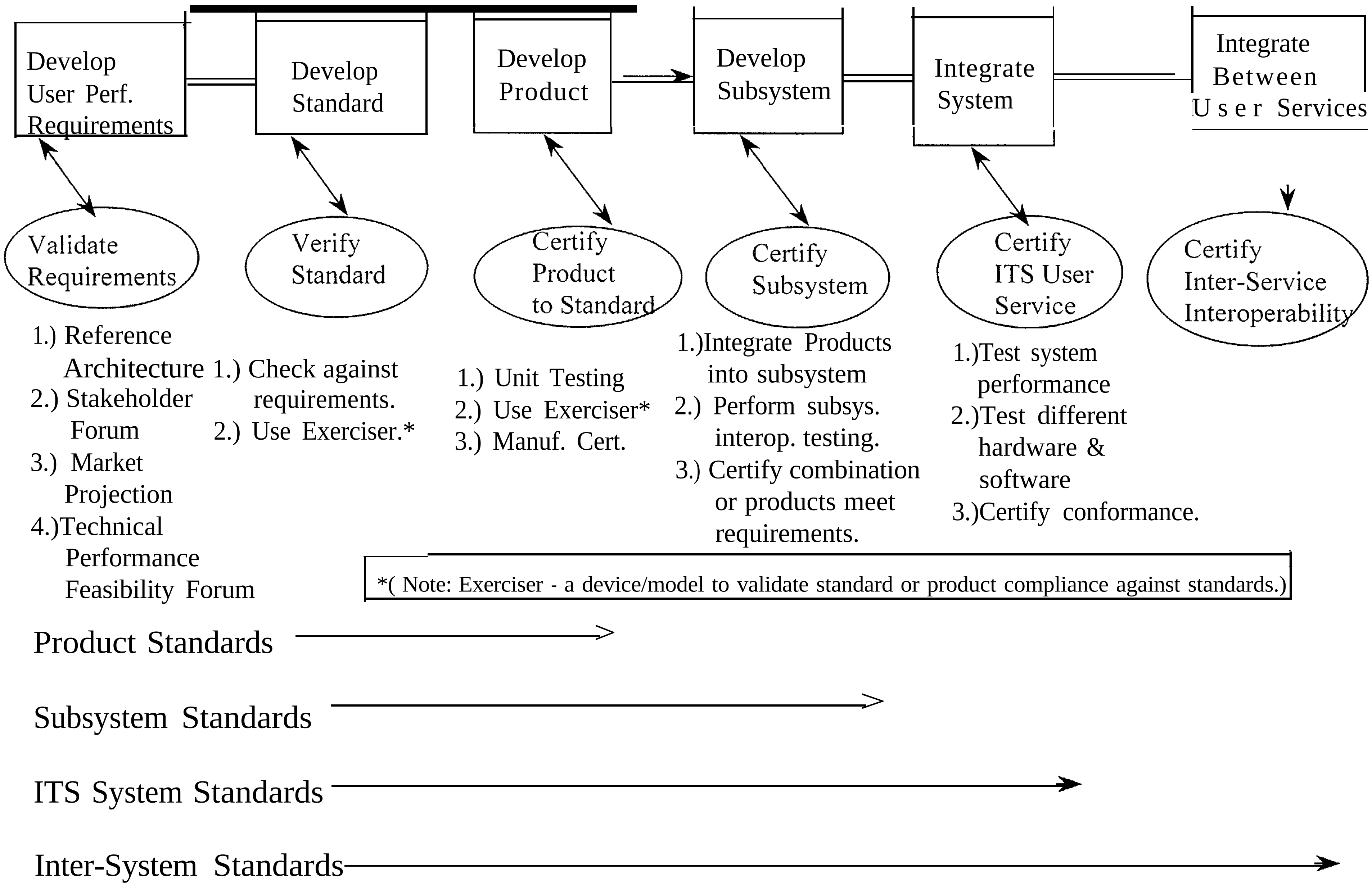
* Interoperability Category or Type: There are three types or categories of interoperability (European Commission Document)
They are as follow:

a) (contractual involving financial agreements and contractual relationships (e.g., MOU's) between operators and user's of an ITS service

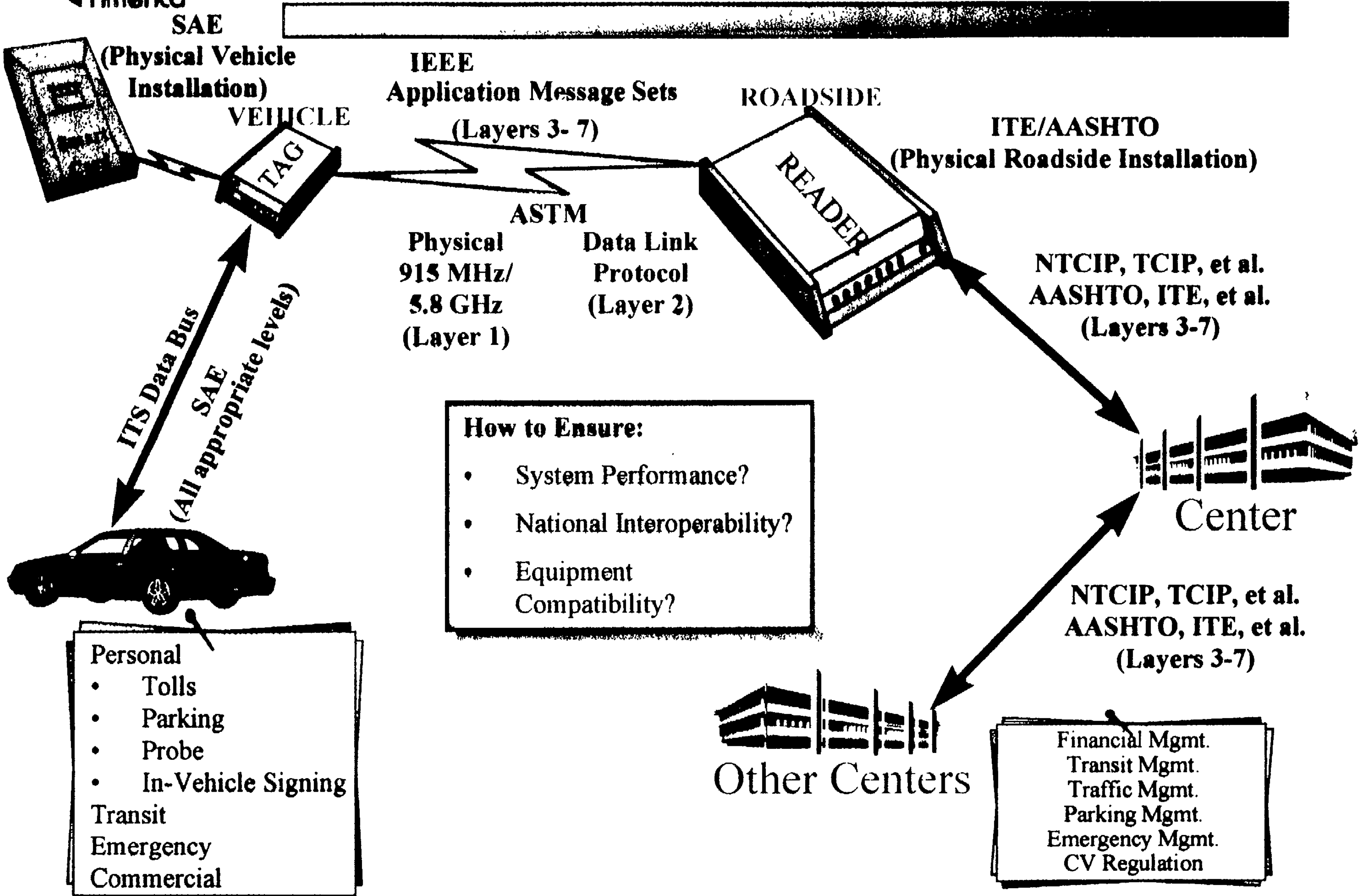
b) interoperability involving data and procedures to exchange meaningful information.

c) technical interoperability which entails the ability of equipment to communicate.

Administrative ITS Interoperability Process



ETTM Application Operational Concept



Source: RSiersman@ITSA.Org

Key Issues

- Matrix Nature of Requirements, i.e. technical, institutional, & data handling
- Interoperability Attributes - safety, performance level, reliability, etc.
- Organization to Define “I” Needs
- Affordable Level of Interoperability
- Conformance Testing/Assurance

A COPY

Metrology for Information Technology (IT)

April 28, 1997

Prepared for MEL/ITL Management

by
MEL/ITL Task Group on Metrology for Information Technology (IT)

NOTE: Only the title page, preface, and selected portions of this document are presented herein as background data for the ITS Standards Workshop of December 17/18, 1997. Those desiring more information can access the white paper on the Internet at
http://www.nist.gov/itl/lab/nistirs/ir6025.htm"

Preface

In May 1996, NIST management requested a white paper on metrology for information technology (IT). A task group was formed to develop this white paper with representatives from Manufacturing Engineering Laboratory (MEL), the Information Technology Laboratory (ITL) and Technology Services (TS) The task group members had a wide spectrum of experiences and perspectives on testing and measuring physical and IT quantities. The task group believed that its collective experience and knowledge sufficient to investigate the underlying question of the nature of IT metrology. During the course of its work the task force did not find any previous work addressing the overall subject of metrology for IT. The task group found it both exciting and challenging to possibly be first in what should be a continuing study.

After some spirited deliberations, the task group was able to reach consensus on its white paper. Also, as a result of its deliberations, the task group decided that this white paper should suggest possible answers rather than assert definitive conclusions. In this spirit, the white paper suggests: a scope and conceptual basis for IT metrology, a taxonomy for IT methods of testing status of IT testing and measurement; opportunities to advance IT metrology; overall roles of NIST, and recapitulates the importance of IT metrology to the us.

The task group is very appreciative of having the opportunity to produce this white paper. The task group hopes that this white paper will provide food for thought for our intended audience: NIST management and technical staff and our colleagues elsewhere who are involved in various aspects of testing and measuring IT.

Task Group Members:

Lisa Camahan (ITL)
Gary Carver (MEL)
Martha Gray (ITL)
Mike Hogan (ITL), Convener
Theodore Hopp (MEL)
Jeffery Horlick (TS)
Gordon Lyon (ITL)
Elena Messina (MEL)

The following is a summary (for sake of brevity) of key material or exact abstracts taken from the 30 page paper as deemed supportive to the ITS Standards workshop by Parsons and Mike Hogan.

The paper defines Information Technology (of which ITS is a small part) and proceeds to address Metrology the science of measurement. It goes on to describe while metrology is well established in the physical sciences (a 200 year history of how to measure"things") little has been written on the subject as it relates to "IT".

The approach used by the NIST task group was to apply proven "metrology" concepts to the IT systems.

A few pertinent definitions are presented as follows:

from page 5

"Quantity - attribute of a phenomenon, body, or substance that may be distinguished qualitatively or determined quantitatively" This appears clear. However, it is necessary to examine the operative elements of this definition in order to apply it to IT. The first requirement is that it is necessary to deal with an attribute (of an IT system). In other words, there must be a specific, distinct property to measure.. ."

from pages 15-17

"Methods of Testing Digital Systems Quantities Copy pages 15-17

Of the five methods of testing identified in the previous section – calibration, conformance testing, interoperability testing, reference data and inspection, all but calibration are in widespread use as methods for testing for digital IT systems quantities. Conformance and interoperability testing often make use of the concept of reference implementations.

The following provides a brief review and status on methods of testing for digital quantities.

Calibration

The concept of calibration is we11 understood in the physical community. Calibration means that the measurement of the value of the properties is related to measurements on primary standards usually provided by primary national laboratory. The relation is traceability.

The purpose of calibration and traceability is to ensure that all measurements are made with the same sized units of measurement to appropriate level of uncertainty so that results are reliably comparable from time to time and place to place.

The definition of traceability is the ability to relate individual measurement results through an unbroken chain of comparisons leading to one or more of the following sources: national primary standards, instinic standards, commercial standards, ratios, and comparison to a widely used standard which is clearly specified and mutually agreeable to all parties concerned

in open systems subcommunity of IT, ISO/IEC TR13223[17] states “Since measurement traceability and calibration are not generally relevant to software and protocol testing the title of clause 9 of this interpretation has been changed to ‘Validation and traceability’.” This report concludes that validation is to software and protocol test tools as calibration is to measurement equipment.

Conformance Testing

The IT method of testing with the greatest amount of experience, widespread use, and development of methodology is conformance testing of digital IT systems. Testing methodologies have been developed for operating system interfaces[18], computer graphics[19], document interchange formats[20], computer networks[21], and programming language processors[22]. Additionally, about fifteen years ago, IT standards developers began to realize that standards for digital IT systems were becoming quite complex and dependent upon both physical metrology and non-physical metrology. Consequently, assessing conformity of hardware/software implementations is now inherently complex and somewhat ambiguous process. There are only a very few documents which address such conformity issues[23,24].

Most of the testing methodology documents cited above use the same concepts, if not the same nomenclature. IT standards are almost always developed and specified in an natural language, English, which is inherently ambiguous. Sometimes the specifictions are originally developed or translated into a more unambiguous language called a formal description technique (FDT). Since the specifications in IT standards are often very complex, as well as ambiguous, most testing methodology documents require the development of a set of test scenarios (e.g., abstract test suites, test assertions, test cases) which must be tested The standards developing activity usually develops the standard, the FDT specification the testing methodology, and the test scenarios Executable test code which tests the test case scenarios is developed by one or more organizations which may result in more than one conformance testing product being available. However, if rigorous testing methodology document has been adhered to, it should be possible to establish whether each conformance testing product is a quality product and an equivalent product Sometimes an executable test code and the particular hardware/software platform it runs on become accepted as a reference implementation for conformance testing. It should be noted that, on occasion a widely successful commercial IT product becomes both the defacto standards and the reference implementation against which other commercial products are measured.

In IT, an example of a primary standards might be a reference implementation of a function (assuming that such an implementation is a measurement standard to begin with). It is possible to have multiple primary standards (or, depending on one’s viewpoint, no primary standard). For instance, a reference implementation of an algorithm may running on two (nominally identical) machines. This raises the issues because the behavior of the two running systems may differ, mechanisms must be established for intercomparison of primary standards.

Interoperability Testing

No interoperability testing methodologies have been established comparable to existing conformance testing methodologies. Interoperability testing usually takes one of three approaches to ascertaining the interoperability of implementations. (i.e. commercial products). The first is to test all pairs of products. Typically an IT market can be very competitive with many products and it can quickly become too time consuming and expensive to test all of the combinations. This leads to a second approach of testing only part of the combinations assuming the untested combinations will also interwork. The third approach is to establish a reference implementation and test all products against the reference implementation.

Reference Data

The use of reference data is very important in both physical and IT metrology When the task group could not find any existing definition for reference data. The task group turned to NIST experts for suggestions, and as a result, Figure 3 has separate definitions for reference data applied to physical and IT metrology. For IT, reference data is used to measure various performance of digital systems.

Inspection

Inspection, as a method of testing, is a concept that applies equally well to either physical or IT metrology. There has been at least one attempt to document an inspection methodology for one area of IT, the evaluation of software products'.

Inspection of complex structures, for instance buildings, in physical metrology has a legacy of many decades of experience. While inspection of digital IT systems is a relatively new area compared to building inspections, there is one advantage in IT metrology. In the area of sofware products, each copy of a product can reasonably be assumed to be identical and inspection of one copy is therefore sufficient to know something about all copies.

The pass/fail decision based on inspection is usually more subjective than objective. This forces two necessary conditions. The first condition is that the inspector (the person performing the inspection) is qualified to make a subjective decision. The second condition is that the surrounding environment be defmed and consistent with similar inspections as possible. For example, to determine that an application produces a correct color for viewing an inspection could be performed The conditions that would be defined for the inspection could be the room lighting, the hardware/software platform of the application, the monitor type used for the inspection, and the expertise of the inspector."

Paper 152

I-95 Corridor Coalition Interoperability Approaches and Lessons Learned

Christine Cox

I-95 CORRIDOR COALTION

I-95 Corridor Coalition

Interoperability Approaches and Lessons Learned

ITS Standards Review & Interoperability Workshop

December 17-I8, 1997

GMU International institute

I-95 CORRIDOR COALITION

Mission Statement

We are working together to implement improved transportation efficiency and services in the Northeast Corridor and to create a seamless, multi-modal, state-of-the-art transportation system.

Coalition Partners

Corridor Boundaries

- Maine
- Vermont
- New Hampshire
- Massachusetts
- Rhode Island
- Connecticut
- New York
- Pennsylvania
- New Jersey
- Delaware
- Maryland
- District of Columbia
- Virginia

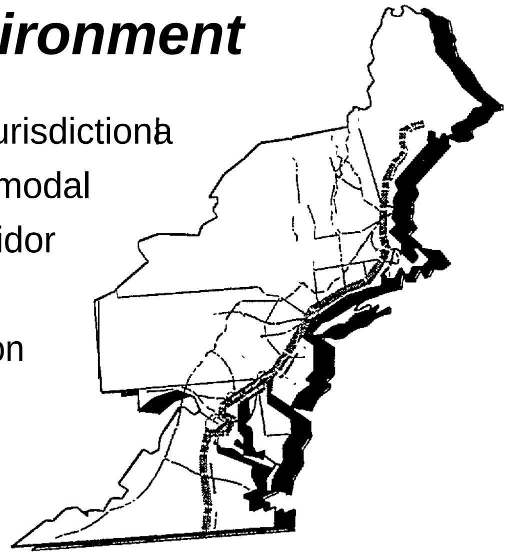
- State and Local Departments of Transportation
- Transportation Authorities
- Transit and Rail Agencies
- Motor Vehicle Agencies
- State Police/Law Enforcement
- U.S. Department of Transportation
- Transportation Industry Associations

A Priority Corridor
(defined in ISTEA)

- Higher than average traffic density
- Severe or extreme ozone levels
- Variety of transportation facilities
- Limits on expansion of its capacity

I-95 CORRIDOR COALTION

Northeast Corridor Environment



- Multistate / Multijurisdictional
- Multimodal / Intermodal
- CVO - Goods Corridor
- Intercity Travel
- 53 Million Population

I-95 CORRIDOR COALITION

Coalition Benefits

- Greater efficiency through coordination
- Mutual support and technical assistance
- Opportunities to learn from each others' experience
- Shared research and development and field testing
- Access to a network of peers

I-95 CORRIDOR COALITION

Why is Interoperability Important in the Northeast Corridor?

- Customer
- Economy

I-95 CORRIDOR COALITION

Institutional Issues

- What are the benefits to my agency?
- Will I lose control of my operation?
- What is the cost?
- How will it work?

I-95 CORRIDOR COALITION

Northeast Corrrdor Activities

- Interregional Coordination of VMS and HAR
- Information Exchange for Incident Notification
- Inter-agency Group
- Regional Consortium for Electronic Toll Collection

I 95 CORRIDOR COALITION

Lessons Learned

- Executive commitment is crucial
- Let individual agencies do what they are most effective at, and honor "home rule"
- Define expectations as specifically as possible in advance
- Plan early!
- Feedback, feedback, feedback

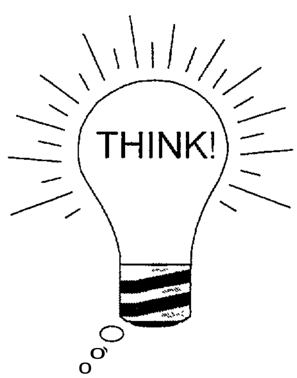
I-95 CORRIDOR COALITION

Lessons Learned

- EFFECTIVENESS = RELATIONSHIPS
- Whole is greater than the sum of the parts

I-95 CORRIDOR COALITION

Lessons Learned



- Interregional
- Interoperable
- Compatible

I-95 CORRIDOR COALITION

Strategies for the Future

- THINK SEAMLESS
- EFFECTIVENESS = RELATIONSHIPS

I-95 CORRIDOR COALITION

Strategies for the Future

- Help the whole to become greater than the sum of the parts
- Link to other ITS efforts
- Expand partners

Paper 153

Japan VICS Program

Matsune Tsurumaru

- VICS -

* VICS and ISO / TC204
* Interoperability of the VICS
* VICS Progress Report

December , 1997

Vehicle Information and Communication System Center

VICS

VICS Participation
in the Japanese Mirror Committee of ISO/TC 204

PARTICIPATION OF THE VICS MEMBERS
IN THE 6 JAPANESE MIRROR SUBCOMMITTEES

- **-WG3 (TICS Database Technology)**
- **-WG9 (Integrated Transport Information Management and Control)**
- **-WG10 (Traveler Information Systems)**
- **-WG11 (Route Guidance & Navigation Systems)**
- **-WG15 (Dedicated Short range Communication for TICS Applications)**
- **-WG16 (Wide Area Communications/Protocols & Interfaces)**

Relationship between VICS and ISO/TC204

WG3
TICS
Database
Technology

WG9
Integrated
Transport
Information
Management
and
Control

WG10
Traveller
Information
Systems

WG11
Route
Guidance
&
Navigation
Systems

WG15
Dedicated
Short
Range
Communicatio
ns
for
TICS
Applications

WG16
Wide
Area
Communication
s/ protocols
&
Interfaces

VICS center

VICS

-WG3

Proposal of the VICS Link ID Format
(Orlando Conference, 10/96)
. Presentation of the VICS conceptual model as an example of the VICS Link ID Format

[Related Documents]
“Location referencing v1.1”
“Conceptual Model for Location Referencing Systems v0.2”

-

VICS

- WG9

- **Production of a message list,**

the smallest unit for messages exchanged among TMIC

[Related Documents]
"Message Format and Information Contexts Traffic Management and Information Centers (TMIC)" :NP1427

VICS

-WG10

- Investigation of the message set proposed from WG11

◇WG11

- Proposal of message set for route guidance (London Conference, 5/96)

  Message set incorporating the VICS method proposed in WG10.

[Related Documents]

"In-Vehicle Navigation Systems Communication Device Message Set Requirements" : NP57

Interoperability of the VICS

Societal foundation

- Traffic information had been collected by road traffic administrators.
  - Traffic management (Traffic signal control, detour management in the event of accidents)
- Research was couducted on information supply media.

Societal needs

- By providing traffic information to drivers, it was hoped that VICS would decentralize traffic flow, achieving a smoother flow of traffic.

Cooperation among government, Academia and Industries

* Government
* Academia
* Industries

Establishment of the VICS center as an information supply organization

Issues related to achieving interoperability (1)

* **Administrators**
  Cooperation between prefectures, between road traffic administrators, between police / road traffic administrators
* **Industries**
  Between navigation system manufacturers, TV manufacturers, auto manufacturers

Issues related to achieving interoperability (2)

* Media

Utilization of currently-existing media

Road traffic administrators : Radio wave beacons (information supply)

Police : Infrared beacons (information collection / supply)

Postal administration : FM multiplex broadcasts

* Levels of supplied information

Utilization of on-board units already being marketed

Level 1 : Text display (using car radios)

Level 2 : Simple graphic display (using car TVs)

Level 3 : Map display (using car navigation systems

* Supplied information

Types of information

Size of information

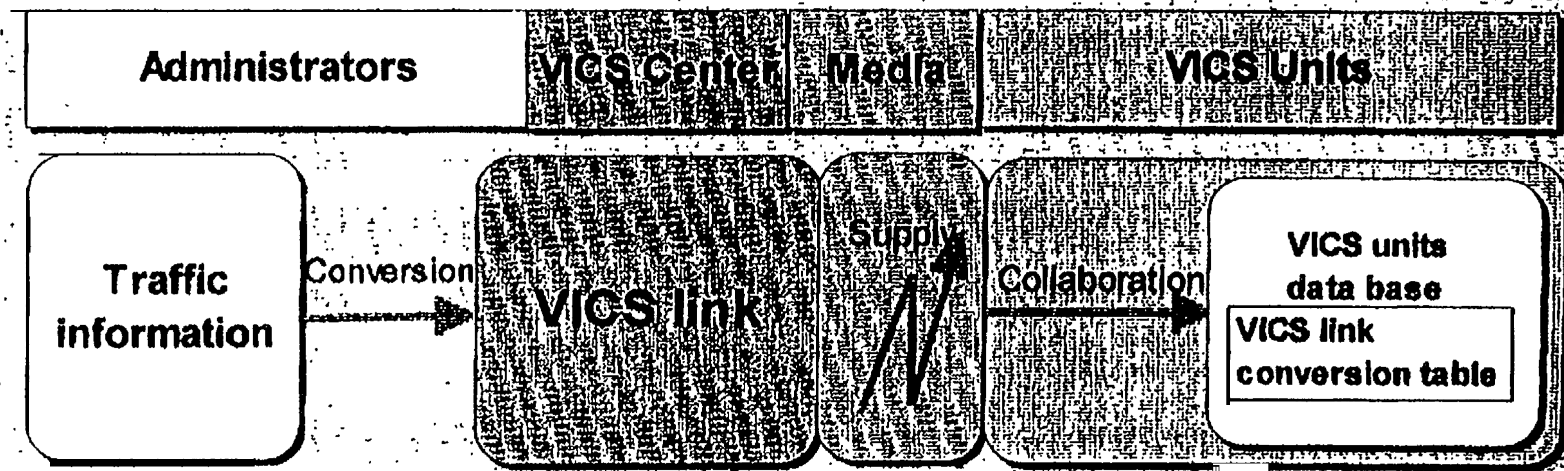
Solutions implemented

* Establish information supply formats
  - Radio-wave beacon format
    (supplies information between road and car)
  - Infrared beacon format
    (supplies information between road and car)
  - FM multiplex broadcasting methods
  - Format for transmissions between center systems

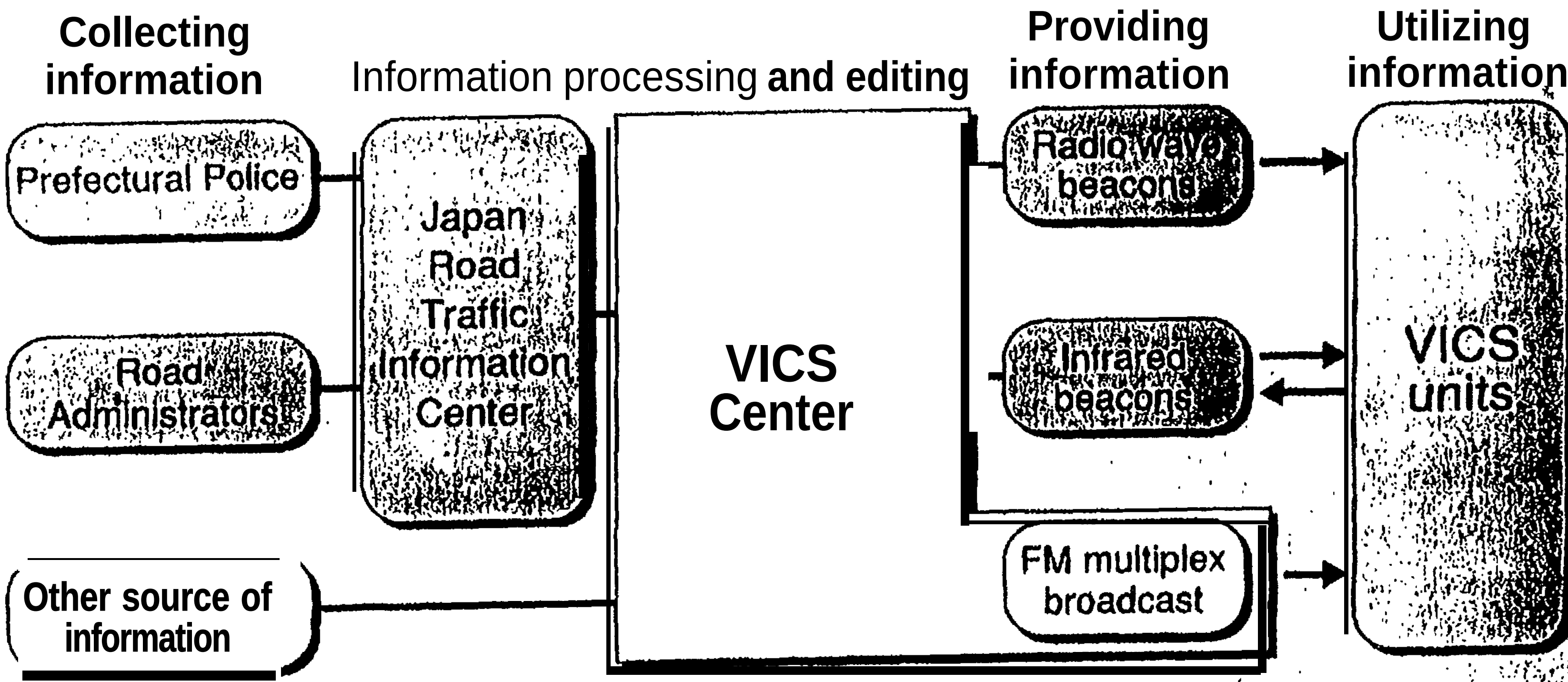
* Levels of information supplied
  - Level 3: Supplied through VICS Link

* Map data
  - Collaborated with the Japan Disital Road Map Association to create a digital data base

Flow of VICS information (Level 3)

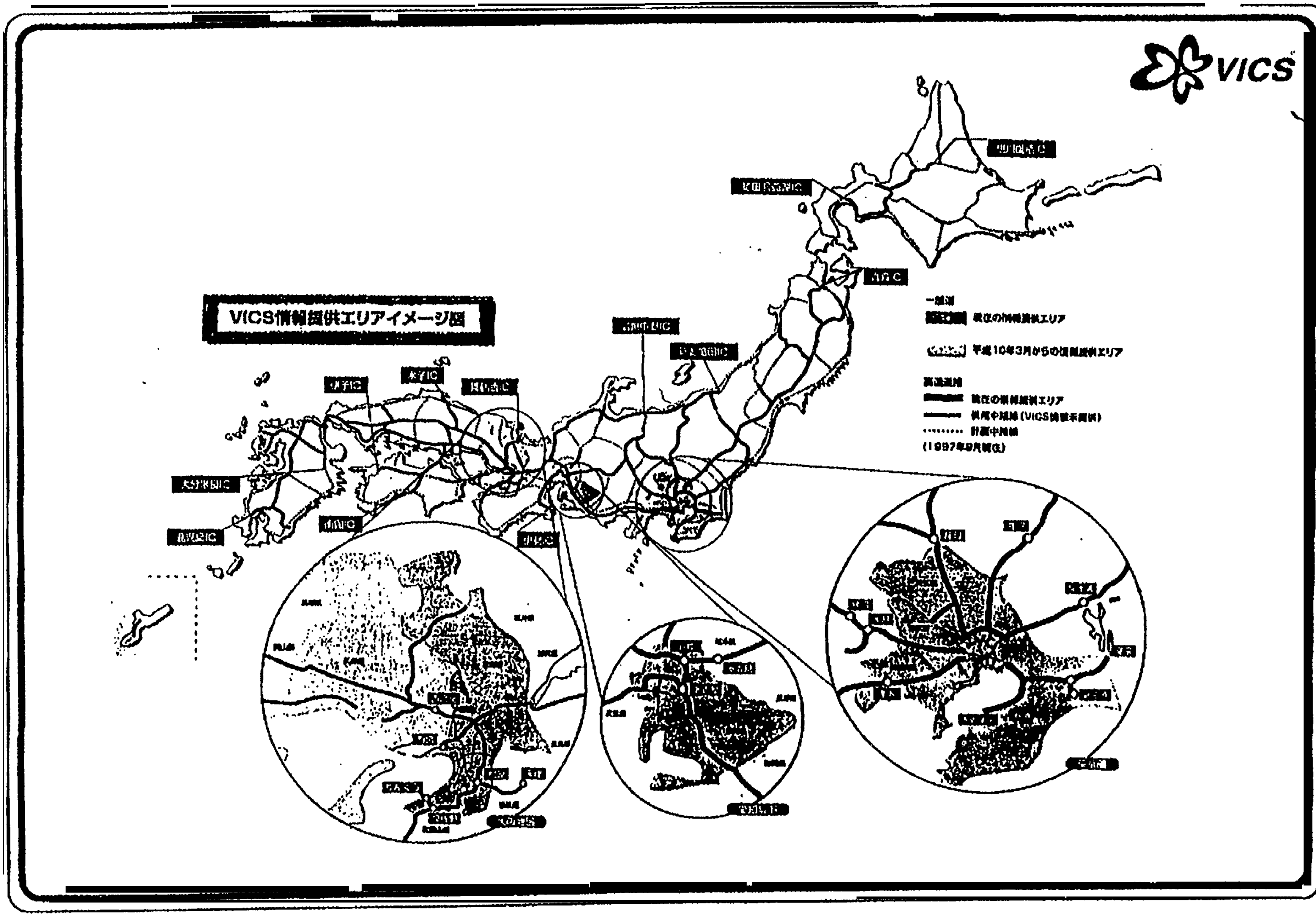


System Configuration



VICS

Information supply Media	Supply Method	Location/Reception Range
Radio wave beacons	Radio wave beacons (road side)	Mainly on expressways
Infrared beacons	Infrared beacons (on roads)	Ordinary roads
FM multiplex broadcast	VICS FM multiplex broadcast	Areas capable of receiving NHK FM broadcasts


VICS情報提供エリアイメージ図
平成10年3月からの情報提供エリア
計画中路線
(1997年9月現在)

Future Plans to Expand the VICS Service Area

<1> Completion of Phase 1 Service Expansion

* Information supply is scheduled to commence in Hyogo prefecture in early 1998.

<2> Information Supply during the Nagano Winter Olympic Games

* During the Nagano Olympic Games, Which will take place in February 1998, VICS information will be supplied to Nagano Prefecture.

<3> Area Development from Phase 2

* We are currently revising our original plan (nationwide VICS coverage to be implemented over three 7-year terms), aiming to develop the VICS area at a more rapid pace and proposing new area of development.

Sale of VICS On-Board Units

1996	APRIL	TO	JUNE	20,699 UNITS
	JULY	TO	SEPTEMBER	34,151
	OCTOBER	TO	DECEMBER	40,458
1997	JANUARY	TO	MACH	33,174
YEAR TOTAL				128,482
1997	APRIL	TO	JUNE	49,299
	JULY	TO	SEPTEMBER	87,908
GRAND TOTAL UNTIL SEPTEMBER 1997				265,689

- TECHNOLOGY INDICATION TO : 41 COMPANIES
- 27 COMPANIES WERE MARKETING 86 TYPES OF VICS ON-BOARD UNITS

Paper 154

Interoperability Approaches. & Lessons Learned - Europe

Andrew Pickford

ITS Standards Review & Interperability Workshop

USDOT / GMU International Institute. Dec17-18. 1997

Interoperability Approaches and Lessons Learned: Europe

Andrew Pickford
Transport Technology Consultants

"The future is already here, is just that its not evenly distributed"

William Gibson (father of 'cyberspace'), 1996

Interoperability: Europe

- Scope for Interoperability
- Dimensions of Interoperability
- Levels of Interoperability
- The 'Interoperability Box'
- 5 examples from Europe
- Smart cards and airlink transparency
- Conclusions

Definition of Interoperability

"The term 'interoperability' at the DSRC level implies that different manufacturers' products can communication with each other at specified interfaces, without modification of the products, to produce a specified result"

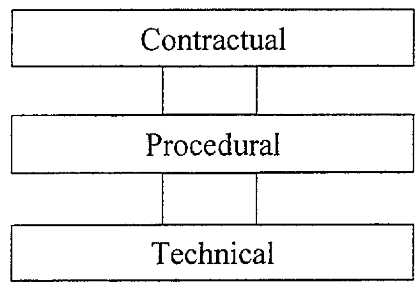
Scope for Interoperability

	USA .	Europe
• Degree of separation	clustered mult-operator	Dispersed. highways and crossings
• Experience	contractual. policy innovations	DSRC, application level validation
• Experience progression	progression towards technical level	progression to contractual
• DSRC technology	monolithic devices, simple interface	monolithic. primitive interface
• Technology progresston	DSRC standards. smart cards	industry initiatives. DSRC validation
• Current drivers	Privatisations. city tolling, CVO	BOT concessions, city tolling
• Future drivers	lnternationalisation. congestion pricing	Internationliation, congestion pricing

Dimensions of Interoperability

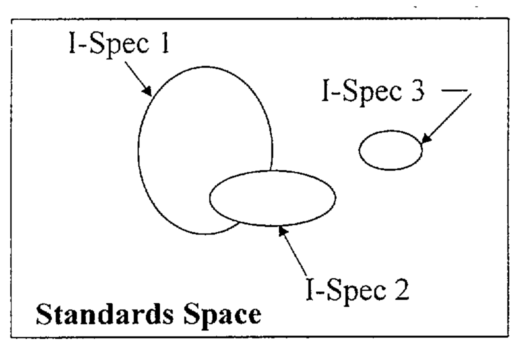
- Airlink: spectrum usage (reuse, stability)
- Classification: vehicle profiles/signatures
- Enforcement: image format, tamper protection mechanisms and ‘watermarks’
- Data: content, message fragmentation
- Electrical: external powering
- Mechanical: tag location, solutions for metallised windshields

Levels of Interoperability



The 3 levels of interoperability

The Interoperability Box



Examples (1): Europe

- 'Rekening Rijden' congestion management (The Netherlands)

Existing 3-5million user base of smart cards for EPOS and public transport use. Smart card not currently applicable to free flow multilane tolling. May reduce ability to leverage from prior investments.

Examples (2): Europe

- Technical and procedural level interoperability:

GSS: industry-led initiative to create public interoperability specification for global application in ETC and CVO areas. Fast method although requires agreed reference standard. Market expansionist.

Examples (3): Europe

- Technical-level coexistence:

Verification of new DSRC technology at existing application. ‘TIS trials’ - new 5.8GHz CVO/ETC system meets 2.45GHz ETC system. Implications on transitional strategy. Benefit from frequency difference.

Examples (4): Europe

- Contractual-level interoperability:

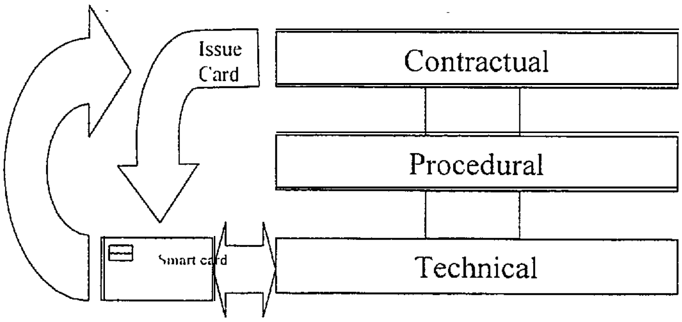
Need for transitional scheme to manage relative strength of operators. MOVE-it ‘Memorandum of Understanding’ between operators in absence of centralised authority. Membership voluntary. Impacts positively on transitional strategy.

Examples (5): Europe

- Technical and procedural level interoperability:

Multiple sourcing, continuous competition, reduction of monopoly power. VASCO created as industry initiative to validate CEN DSRC standard and good basis for equipment validation and certification.

Interoperability: Europe



Levels of interoperability and the role of the smart card (e.g. GSM)

Conclusions (1)

"Standardisation should not be seen as an 'end' in itself but only as part of the process to encourage the development of interoperable systems"

"When ETC Systems Collide", 1996

Conclusions (2)

- Needs-driven: geographic or application convergence. Find core application.
- Review existing assets (technology, policies, standards, incentives)
- Focus on implementation and transitional methods
- Technical co-existence between DSRC systems of different frequencies is possible

Conclusions (3)

- Transitional schemes important at all levels of interoperability heirachy.
- Smart cards can 'enable' contractual interoperability. MOUs useful.
- Industry initiatives useful if not critical
- Market-driven perspective.
- Question 'popular beliefs'

Conclusions (4)

Interoperability

OR

intraoperability ?

